

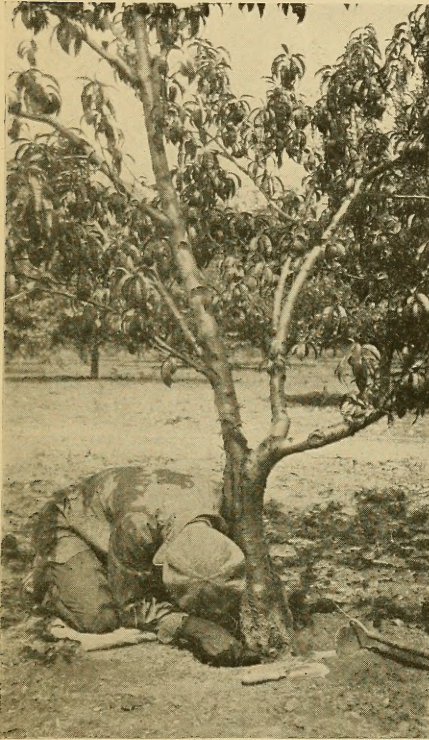
5
91
E26X
ENT

Para-dichlorobenzene (p-c-benzene) for Controlling the Peach-Tree Borer

(Revised)

ALVAH PETERSON

THE OLD AND THE NEW IN PEACH-TREE BORER CONTROL



1. OLD METHOD—"WORMING."



2. NEW METHOD—PARA-DICHLOROBENZENE

NEW JERSEY
AGRICULTURAL EXPERIMENT STATIONS

NEW BRUNSWICK, N. J.

September, 1923

CONTENTS

	PAGE
Introduction	3
General information on the peach-tree borer.....	3
“Worming” process	4
Para-dichlorobenzene	5
Age of trees—short treatments.....	6
Dosage	7
Method of application.....	8
Time of application.....	8
Greenhouse peach trees.....	9
Plum and cherry trees.....	12
Borers in other plants.....	12
Conclusions	12

Para-dichlorobenzene (p-c-benzene) for Controlling the Peach-tree Borer¹

ALVAH PETERSON,
Assistant Entomologist

Introduction

The information summarized in this revised circular will give the peach growers of New Jersey our latest information and recommendations on the use of para-dichlorobenzene for the control of the peach-tree borer, *Sanninoidea exitiosa* Say. A more complete publication discussing all of our investigational work on the peach-tree borer is prepared and will appear in the near future as a technical bulletin.

General Information on the Peach-Tree Borer

Wherever peaches are grown in the United States east of the Rocky Mountains the trunk and large roots of the tree may be seriously infested with a white worm (larva) which feeds on the outer living layers of the tree. An infestation of peach-tree borers may be detected by the presence of masses of gum containing sawdust-like particles (excrement) exuding from the trunk of the tree near the ground. If this infestation is serious trees may be girdled completely in one or more seasons.

The larvae feed actively in the fall, spring and summer months; during the cold winter they are more or less dormant. When the larvae become full grown during the summer they construct cocoons about their bodies, composed of particles of excrement or bark bound together with wax and silk, and turn into brown pupae. The cocoons may be found on the trunk in the old burrows or in the soil adjacent to the tree. In three or more weeks the adult moths emerge.

The majority of the adults appear in New Jersey between July 1 and September 15, although a few may emerge before and after these dates. The moths are clear-winged and fly during the day. They resemble some of the wasps. The female moth is a deep steel blue with a bright orange band about the abdomen; the fore-wings are opaque and the hind wings clear. The male is a trifle smaller than the female, has clear wings, except the margins, three or four narrow yellow stripes on the abdomen and yellow areas on the head and thorax.

The female lays 200 to 800 eggs. Most of these are deposited on peach trees and when placed on the tree most of them are located near the ground. The eggs hatch in nine or ten days if the temperature is sufficiently high. A newly hatched larva is about 1/16 inch long, while a full grown larva may be 1¼ inches long. The majority of the newly hatched larvae enter the tree just below the surface of the soil, some will enter the trunk above ground, while others may enter several inches below the ground. For the average season in New Jersey there is one generation; in some cases, so far as has been observed, the larvae probably remain in the tree for two winters.

¹Prepared July 1, 1923, as a revision of Circular 126, New Jersey Agricultural Experiment Stations.

"Worming" Process

Before the discovery of para-dichlorobenzene as a control measure for the peach-tree borer the "worming" process or "worming" was considered by entomologists and most fruit growers as the best procedure for combating the pest. There are good, bad and indifferent methods of "worming." Personal observation and considerable experience in the removal of borers from peach trees convinces the author that the following method is satisfactory and much more efficient than some methods he has seen.

If an orchard is heavily infested the trees should be "wormed" twice a year—in the fall, late in September or during October, and in the spring, during April and May. In the fall the majority of the larvae are small, difficult to see and are located on the outside of the tree or in shallow channels, while in the spring the larvae are larger, easy to see, and usually located deeper in the tree. Removal of the larvae in the fall protects the tree from injury until the next brood appears, yet the larvae are small and one must have good eyes to see them.

The first step in the "worming" process is the removal of enough soil from about the tree to expose the trunk and the upper portion of the large roots. A hoe or some similar tool is most satisfactory for this. As the dirt is taken away all excess masses of gum on and about the trunk should be removed. This may be done with a small hand trowel. Any larvae found at this time should be killed but no serious attempt should be made to kill the borers within the tree when the soil is removed. Permit the trees to stand open for a period of 7 to 10 days. During this interval the larvae within the trees will continue to feed and masses of gum containing sawdust-like particles will exude from the trunk near the location of each larva. These exudations of gum serve as guides to the location of the larvae and digging near these points only will eliminate a great deal of unnecessary and harmful cutting.

When the trees are ready for "worming" the worker should be equipped with a hand soil-digging tool (the author prefers a narrow strong trowel), a strong sharp-pointed knife with one non-jointed blade, and a stiff wire (4 to 6 inches long and $\frac{3}{16}$ to $\frac{1}{4}$ inch thick) pointed and slightly bent at the end and mounted in a wooden handle. The trowel is used to remove excessive masses of gum, large pieces of dead bark, and for digging out any soil which may cover some of the infestations located low in the tree. The knife is used to cut the bark and open up a cavity sufficiently large to see or locate the borer. In using the knife, so far as possible, always cut up and down on the trunk. Make as few horizontal cuts as possible. Numerous or long horizontal cuts will girdle the tree. After the larva is located kill it with the knife blade or use the sharp pointed stiff wire. Use the wire as often as possible for it eliminates unnecessary and dangerous cutting.

After the trees have been examined and wormed once permit them to stand for 7 days and then repeat the examination and "worming." Two examinations or "wormings" are entirely worth while. At the first "worming" the average person will remove only 40 to 60 per cent of the borers and on the second "worming" most of those missed the first time can be

found. The author has repeatedly had the experience of returning to trees which have been carefully "wormed" and examined two, three and in some cases four times, and finding a few larvae if a large number of trees are examined. It is almost impossible to remove all of the larvae in a heavily infested tree by "worming" and at the same time produce little or no injury by cutting. If it is necessary to cut the tree severely to reach a larva the operation will be as detrimental to the tree as the injury the larva may produce.

When the "worming" process is complete replace the soil as soon as possible and mound it up around the tree about one foot. The presence of a mound about the tree during the summer is desirable if the "worming" process for the control of the borer is practised. The mound about the tree causes most of the larvae to enter the tree above the general level of the ground and this makes it easier to "worm" the trees. If para-dichlorobenzene is employed as a control measure no mounds of dirt should exist about the tree during the summer because the most successful results are obtained with the gas treatment when the majority of the larvae are in the tree at or just below the general level of the soil. The presence of a mound about the tree during the winter protects the trunk from frost injury.

Para-dichlorobenzene

(P-C-Benzene)

Chemically pure para-dichlorobenzene ($C_6H_4Cl_2$) is a white crystalline solid that is insoluble in water and vaporizes slowly at ordinary temperatures. Crystals of para-dichlorobenzene small enough to pass through a sieve with 10 meshes to the linear inch are most desirable. Large solid lumps are not satisfactory. The crystals should be dry. If wet or partly submerged in a liquid the substance is not chemically pure. The liquid or wet condition indicates the presence of highly toxic (for plants) chlorinated benzene products. The vapor of para-dichlorobenzene is heavier than air. One-ounce treatments placed about peach trees when the soil temperature is 70° F. or higher requires about six weeks or longer for complete evaporation, while similar treatments made late in the fall (November) when the soil temperature is 50° F. or lower will remain about the trees until late in the spring or early summer of the following year.

So far as is known para-dichlorobenzene is non-poisonous to man and poultry, but it is decidedly poisonous to most insects when they are exposed to the fumes for a considerable period of time. The gas is also injurious to tender roots and the growing tissue of most plants. Fortunately the bark on peach trees, particularly on trees three years of age or older, appears to act as a barrier and protects the growing tissue about the cambium layer when para-dichlorobenzene is applied. Most peach trees treated with para-dichlorobenzene will show some discoloration, a dark or reddish brown color, in the outer bark. This abnormality appears to be of no importance. When more severe injury occurs the light-colored tissues near the cambium layer contain numerous small brown specks. If the injury is serious the specks become enlarged and join together forming a continuous brown dead

layer of tissue. Dead tissue is usually dry and tight against the hard wood.

Para-dichlorobenzene is called or is obtainable in the market under the names para-dichlorobenzene, para-dichlorobenzol, "Paracide," "Krystal Gas," "P.D.B.," paradichlor, etc.

Para-dichlorobenzene seems to be a difficult word to remember and pronounce, consequently the author suggests the abbreviation "p-c-benzene." Some companies are placing on the market compounds for the control of the peach-tree borer which contain a small or large percentage of para-dichlorobenzene plus a small or large amount of inert substances. Since pure para-dichlorobenzene is the only chemical known which has proved to be satisfactory in the control of the peach tree borer, the author sees no reason for making use of, or paying for compounds containing substances other than para-dichlorobenzene when one can obtain pure crystalline para-dichlorobenzene. If a compound contains 25 per cent para-dichlorobenzene, it will be necessary to use four times as much of the compound as of the pure para-dichlorobenzene to obtain a satisfactory dose. In case a compound containing substances other than para-dichlorobenzene is used, the para-dichlorobenzene content of the product should be ascertained before it is employed. The price of pure para-dichlorobenzene ranges from \$.20 to \$1.00 per pound. In 100-pound lots peach growers in New Jersey have obtained pure para-dichlorobenzene for 20 to 30 cents per pound. Trees 6 years of age or older may be treated (including the labor cost) for 2 to 4 cents per tree.

Age of Trees—Short Treatments

Our experiments and observations to date warrant us to recommend the use of para-dichlorobenzene on infested peach trees (in the orchard) of all varieties which are 3 years of age or older. For trees 6 years of age or older the para-dichlorobenzene may be permitted to evaporate without removal, while on trees 3 to 5 years of age we advocate the removal of the crystals as soon as the larvae are dead. The length of time required to kill the borers depends upon soil temperature, size of the larvae and to some extent upon the moisture content of the soil. Under most conditions when the soil temperature 3 to 6 inches deep averages 55° to 70°, 3 weeks' exposure will kill the maximum number of the larvae (90 to 100 per cent). Average soil temperatures between 55° and 70° F. at a depth of 3 to 6 inches occur during May, early in June, September and early in October in New Jersey. During most of June and in July and August the average soil temperature is 70° F., or higher. High soil temperature brings about a rapid evaporation of para-dichlorobenzene crystals and trees subjected to a great concentration or distribution of the gas are apt to show the maximum amount of injury. To kill large larvae a longer exposure to a given amount of gas is required than with small larvae. Unless the soil is exceedingly wet, so that all of the pores are filled with water, the moisture content of the soil will not interfere with the results in a 3 weeks' exposure. Soil texture appears to have little or no influence on the results.

When employing a short treatment on trees 3 to 5 years of age the para-dichlorobenzene is applied in the manner described. After 3 weeks when the larvae are dead, the dirt of the mound and unevaporated crystals are

pulled away from the trunk (with a hoe) and fresh dirt free of para-dichlorobenzene is replaced. In case short treatments are used in May or early in June no dirt should be permitted to remain mounded about the tree for the summer period. Remove the mound of soil and crystals about the tree and permit the soil adjacent to the tree to be at general soil level. Prolonged treatments on trees 3 to 5 years of age may produce unnecessary, and in some cases severe injury to the trunk and large roots.

We do not recommend the use of para-dichlorobenzene on infested 1- and 2-year-old peach trees in the orchard or for peach trees in the nursery. In our experiments a large number of trees 1 and 2 years of age have been given short treatments, $\frac{1}{4}$ to $\frac{3}{8}$ ounce being used on 1-year-old trees, and $\frac{3}{8}$ to $\frac{1}{2}$ ounce on 2-year-old orchard trees for 3 weeks, and satisfactory results have been obtained. In some cases, however, considerable injury has been produced, consequently we cannot give an unreserved recommendation. Several reliable peach growers in New Jersey have made short treatments (2 to 3 weeks) of $\frac{1}{4}$ ounce on 1-year-old trees and $\frac{3}{8}$ ounce on 2-year-old trees for two seasons, and their orchards today appear to be in fine shape. A goodly number of peach trees (several hundred) in one nursery have been given short and long treatments with an average of $\frac{1}{4}$ ounce of para-dichlorobenzene per tree. The borers were killed, and to date we have seen a surprisingly small amount of permanent injury. Since our experiments have been conducted with nursery trees on only one kind of soil, Penn loam, we cannot recommend the use of para-dichlorobenzene for nursery stock.

The author is of the opinion that the general condition or health of an infested peach tree is as important as the age of the tree when one considers susceptibility of the tree to para-dichlorobenzene. Trees weakened by frost injury or other causes are more susceptible to injury from para-dichlorobenzene than healthy trees.

In our experiments several poorly kept (lacking cultivation, spraying and fertilizers) and heavily infested orchards 6 to 12 years of age were treated, and severe injury resulted. In some cases 10 per cent or more of the trees died as a result of the treatment. The killed trees were in poor shape and the treatment undoubtedly hastened their death. Comparing these results with those obtained in other heavily infested orchards that received good care (ample and careful cultivation, spraying and fertilizers) no trees were killed or seriously injured where para-dichlorobenzene treatments were made. The author is convinced that weak trees and poorly cared for trees are more susceptible to injury than healthy trees properly cared for. In using para-dichlorobenzene one much remember that para-dichlorobenzene is a fumigant toxic to plant and insect life.

Dosage

Doses of $\frac{3}{4}$ to 1 ounce per peach tree 6 years of age or older kill 90 to 100 per cent of the peach-tree borers and produce little or no injury in the average commercial orchard. One-half ounce per tree for 3 weeks on trees 3 to 5 years of age gives satisfactory results provided the soil temperature averages 55° to 70° F. In our experiments on 1- and 2-year-old trees $\frac{1}{4}$ ounce and $\frac{3}{8}$ ounce per tree, respectively, have killed the borer.

Method of Application

Prepare a tree for an application of para-dichlorobenzene by removing with a hoe the weeds, grass, leaves, stones, sticks, etc., from about the base of the trunk for a distance of 6 to 12 inches. In other words, clear away the trash and make the soil smooth about the base of the tree. Do not dig into the surface any more than necessary. In case large masses of gum are present remove most of it with a hoe or some similar tool.

When the tree is ready for treatment measure out the amount of para-dichlorobenzene to be used in some container which is graduated or holds when level full the required amount; a short wide-mouth bottle, a tin or wooden pill-box may answer the purpose. Some growers measure out 1 ounce in a closed fist. Take a handful of the crystals and then close your hand tightly with the first joints of the fingers straight. The size of your hand will determine the amount you can hold in this way.

The crystals should be evenly distributed in a continuous narrow circular band approximately 2 inches from the tree. Do not place the crystals against the trunk, for serious injury may result. Material placed 4 to 6 inches from the tree has given fairly satisfactory results provided the soil is dry and plenty of dirt is placed above the crystals.

After the material is in a ring about the tree, place several shovelfuls (four to six) of dirt free of weeds, grass, sticks, large stones, etc., over the crystals and compact them with a shovel or a hoe or otherwise. The first shovelful of earth placed above the "death ring" should be finely divided and carefully placed upon the crystals in order that the position of the para-dichlorobenzene will not be disturbed.

If infestations are located high in the tree, 1 to 6 inches above the soil, the larvae so located can be killed by piling a large amount of dirt over the crystals (at soil level) and above the highest infestation. Or the application may be divided, placing half of the required amount at soil level, and covering this with several (2 to 5) inches of soil, and then placing the remaining half of the dose on the upper level and covering this again with several inches of soil. The last method is more apt to give satisfactory results than the first. If crystals are placed on a newly constructed mound of soil several inches above soil level and no crystals are placed at soil level the larvae above ground will be killed but the gas will not penetrate the ground in sufficient quantity to kill the larvae located in the trunk or large roots several inches below the surface.

Time of Application

The results of several seasons of experiments and observations with para-dichlorobenzene show that the best time to apply the fumigant is in the fall immediately after all of the eggs of the peach-tree borer have hatched. For an average season in New Jersey this is September 15 for the northern half of the state and October 1 for the southern half. A fall treatment is most satisfactory because the majority of the larvae are small and easy to kill. In the fall most of the larvae are located in the outer layers of the trunk and roots, the trees exude less gum than in the spring and the soil is apt to be dry, or at least not saturated with water. All of these facts

are favorable for the most satisfactory results in soil fumigation for the control of the peach tree borer. A clean-up of the peach-tree borer in the fall means uninfested trees from October to July or August the following year when the new brood appears. One application per season is sufficient if the application is carefully and properly made in the fall.

Para-dichlorobenzene will kill the borers present in a peach tree but it will not prevent an infestation. Newly hatched larvae will enter and live in peach trees that have a "death-ring" of para-dichlorobenzene about them. The point of entrance of the larvae is near the top of the mound of soil placed over the para-dichlorobenzene. Furthermore, adult females will deposit eggs on peach trees that have para-dichlorobenzene about them. Several growers in New Jersey have experienced poor results with para-dichlorobenzene in the control of the peach-tree borer because they applied the fumigant late in August or early in September before all of the eggs had hatched.

In case a fall application is not made or poor results were obtained a short spring treatment during the month of May will give fairly satisfactory results. During May the soil is sufficiently warm to produce good results in 3 weeks' exposure. The percentage of dead borers may be a little smaller than from a similar treatment made in the fall. If a spring application is made most of the larvae present in the tree will be killed but this will not keep the borers out during the summer months. In other words, an application should be made again in the fall. So far we have seen no serious results where trees 3 years of age or older received two applications per season.

Mid-summer applications are useless, for the peach-tree borer may be found in all stages—egg, larva, pupa and adults—and the treatment will only kill the larvae and pupae. Furthermore, the high soil temperature of mid-summer produces a rapid evolution of the gas and this in turn produces the maximum amount of injury.

Late fall applications, made after October 15 and before the ground freezes on trees 3 years of age or older, will kill most of the borers in the trees provided the para-dichlorobenzene is allowed to remain in the ground until the soil temperature becomes approximately 60° the following spring. Some injury may be produced by a late application.

In several 3-year-old orchards, where para-dichlorobenzene remained about the trees from October 15 or later to April 1, May 1 and June 1, the greatest amount of injury occurred on the trees uncovered June 1. If a late application is made on trees 3 to 5 years of age it is advisable to remove the crystals of para-dichlorobenzene the following spring late in April or early in May before the soil temperature becomes too high.

Greenhouse Peach Trees

Infested peach trees grown in pots, tubs or in the ground in greenhouses may be treated with para-dichlorobenzene to control the borer. The safest and most satisfactory time of the year is in the fall immediately after all of the eggs have hatched and when the trees are more or less dormant or losing their leaves. Dwarf peach trees 6 years of age or older

THE RIGHT AND WRONG WAY TO APPLY PARA-DICHLOROBENZENE

Fig. 1. The soil about the peach tree made smooth and ready for treatment.

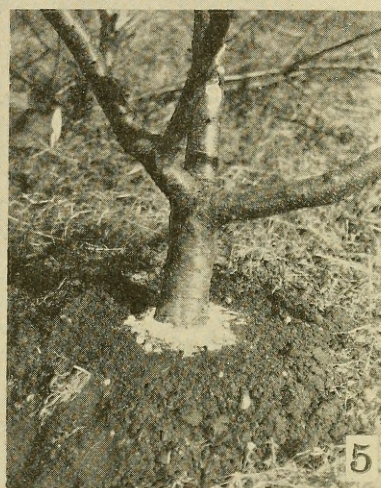
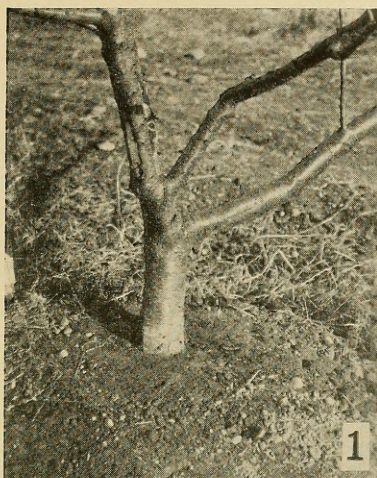
Fig. 2. A correct treatment. One ounce of finely divided para-dichlorobenzene placed on the soil about the tree in a continuous narrow band approximately 2 inches from the tree.

Fig. 3. Four to six shovelfuls of dirt free of grass, large stones, sticks, etc., placed on top of the para-dichlorobenzene, 3 to 6 inches deep and packed down.

Fig. 4. An incorrect treatment. The bulk of the gum should be removed before the para-dichlorobenzene is placed about the tree. If larvae are located in the trunk above soil level, place enough dirt about the tree and above the crystals to cover all of the points where the gum is exuding or split the treatment, applying one-half of the required amount of para-dichlorobenzene at soil level and the remaining one-half on a layer of soil 2 to 5 inches above the first application.

Fig. 5. An incorrect treatment. Crystals placed against the tree may cause unnecessary and serious injury. All crystals should be about 2 inches from the tree. Also note the large lumps present; these are undesirable.

Fig. 6. An incorrect treatment. In this figure the material is placed too far away (6 inches) from the tree to be most effective as a killing agent for all of the borers. This is particularly true when the soil is wet.



require $\frac{1}{2}$ ounce of para-dichlorobenzene. Apply the crystals in the manner described and then after the application is complete cover the mound of soil with a paper cone so the soil and crystals will not be disturbed when the trees are watered. If the roots are at the surface of the soil when the para-dichlorobenzene is applied place an inch of soil over them before the application is made. After 3 weeks completely remove the gas-filled mound of soil and crystals from the pots or tubs. Do not permit crystals to remain on the surface, for subsequent watering will wash the crystals into the soil and the roots may be seriously injured.

The author has not had experience with greenhouse peach trees less than 6 years old, consequently no recommendation will be made for trees of this age.

Plum and Cherry Trees

So far as has been observed peach-tree borers in plum and cherry trees 6 years of age or older can be safely and satisfactorily controlled with para-dichlorobenzene. Follow the directions given for peach trees 6 years of age or older.

Larvae of the American plum borer (*Euzophera semifuneralis* Walk) commonly found in plum and cherry trees and occasionally in peach trees are killed by para-dichlorobenzene treatments provided the larvae are located in the tree below ground or near soil level. The larva of this insect is often located high on the trunk of the tree and in the large branches.

Borers in Other Plants

Considerable, serious, or fatal injury is produced if para-dichlorobenzene is used to kill the round-headed apple-tree borer (*Saperda candida* Fab.) in apple trees. In our experiments short treatment of $\frac{1}{2}$ or 1 ounce for 3 weeks in the spring and fall produced some injury and did not kill all of the borers. Prolonged treatments produced serious to fatal injury.

Considerable injury which may be fatal is produced if para-dichlorobenzene is used to kill the blackberry crown borer (*Bembecia marginata* Harris) in blackberry bushes. Both short treatments (3 weeks in length) and prolonged treatments of $\frac{1}{2}$ to 2 ounces per blackberry bush killed most of the borers and injured and in most cases killed the bushes.

Conclusions

The peach-tree borer in trees of all ages may be controlled by the "worming" process.

Para-dichlorobenzene may be used in the control of the peach tree borer in orchard peach trees 3 years of age or older. For trees in the nursery or 1- and 2-year-old trees in the orchard there still exists an element of doubt as to the advisability of an unreserved use of para-dichlorobenzene. Peach-tree borers in greenhouse peach trees 6 years of age or older may be controlled with para-dichlorobenzene.

Para-dichlorobenzene may be used in the control of peach-tree borers in plum and cherry trees 6 years of age or older.

Para-dichlorobenzene is very toxic to apple trees and blackberry bushes, consequently borers in these plants cannot be safely controlled with this fumigant.

Station

SMITHSONIAN INSTITUTION LIBRARIES



3 9088 01585 4268